CLAIMS TO INVENTION:

1. A liquid crystal optical element for imparting a predetermined phase-shift to light having wavelengths within a predetermined optical band, comprising:

a liquid crystal film structure having first and second surfaces disposed substantially parallel to each other and embodying liquid crystal molecules between said first and second surfaces; and

at least one phase retardation region formed along said first surface of said liquid crystal film structure, where the liquid crystal molecules within said phase retardation region are oriented along a direction and to a surface depth sufficient to impart a predetermined phase shift to said light transmitted therethrough,

said phase retardation region having an optical axis specified by the direction and depth of orientation of said liquid crystal molecules within said region.

2. The liquid crystal optical element of claim 1, wherein said phase retardation region comprises a nematic phase region.

3. The liquid crystal optical element of claim 1, wherein said phase retardation region comprises a smectic phase region.

4. The liquid crystal optical element of claim 1, which further

comprises a circularly polarizing region disposed between said first and second surfaces of said liquid crystal film structure, wherein the liquid crystal molecules are cholesterically ordered to circularly polarize light transmitted therethrough having a wavelengths within said predetermined optical band.

5. The liquid crystal optical element of claim 4, wherein light transmitted through said first and second surfaces is linearly polarized.

6. The liquid crystal optical element of claim 5, wherein said phase retardation region comprises a nematic phase region.

7. The liquid crystal optical element of claim 5, wherein said phase retardation region comprises a smectic phase region.

8. A liquid crystal linear polarizer for linearly polarizing light having a wavelengths within a predetermined optical band, comprising:

a liquid crystal film structure having first and second surfaces disposed substantially parallel to each other and embodying liquid crystal molecules between said first and second surfaces;

a chiral phase region formed between said first and second surfaces of said liquid crystal film structure, wherein the liquid crystal molecules within said chiral phase region are cholesterically ordered to form a circularly polarizing region, for circularly polarizing light transmitted therethrough having a

wavelengths within a predetermined optical band; and

at least one nematic phase region formed along said first surface of said liquid crystal film structure, wherein the liquid crystal molecules within said nematic region are oriented along a direction and to a surface depth sufficient to form at least one phase retardation region therein, for imparting a quarter-wave phase shift to said light transmitted therethrough,

said phase retardation region having an optical axis specified by the direction and depth of orientation of said liquid crystal molecules within said nematic phase region, and said light transmitted through said first and second surfaces emerging linearly polarized along the direction of said of optical axis.

9. A cholesteric liquid crystal optical element comprising:

a solid-state liquid crystal film structure having first and second principal surfaces, and left-handed cholesterically ordered liquid crystal molecules distributed over at least a selected portion of said solid-state liquid crystal film structure, for reflecting left-hand circularly polarized light within a predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure, while transmitting either right-hand circularly polarized light or incident light having a wavelength outside within said predetermined characteristic reflection bandwidth;

a phase-retardation region integrally formed though said first or second principal surface, having an optical axis and birefringent phase-retardation characteristics for imparting a

predetermined amount of phase retardation to a characteristic wavelength of said incident light passing through said phase-retardation region;

wherein said left-handed cholesterically ordered liquid crystal molecules over said phase-retardation region are reoriented along a specified orientation direction to a predetermined depth within said solid-state liquid crystal film structure,

said optical axis extends along said specified orientation direction, and

said predetermined amount of phase retardation is determined by said predetermined surface depth to which the left-handed cholesterically ordered liquid crystal molecules within said phase-retardation region are reoriented along said specified orientation direction.

10. A liquid crystal optical element comprising:

a solid-state liquid crystal film structure having first and second principal surfaces, and right-handed cholesterically ordered liquid crystal molecules distributed over at least a selected portion of said solid-state liquid crystal film structure, for reflecting right-hand circularly polarized light within a predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure, while transmitting either left-hand circularly polarized light or incident light having a wavelength outside within said predetermined characteristic reflection bandwidth;

a phase-retardation region integrally formed though said

first or second principal surface, having an optical axis and birefringent phase-retardation characteristics for imparting a predetermined amount of phase retardation to a characteristic wavelength of said incident light passing through said phase-retardation region;

wherein said right-handed cholesterically ordered liquid crystal molecules over said phase-retardation region are reoriented along a specified orientation direction to a predetermined depth within said solid-state liquid crystal film structure,

said optical axis extends along said specified orientation direction, and

said predetermined amount of phase retardation is determined by said predetermined surface depth to which the right-handed cholsesterically ordered liquid crystal molecules within said phase-retardation region are reoriented along said specified orientation direction.

11. A solid-state liquid crystal phase retardation structure, comprising:

a solid-state liquid crystal film structure having a first principal surface and said second principal surface disposed substantially parallel to said first principal surface, and liquid crystal molecules distributed between said first and second principal surfaces over at least a selected portion of said solid-state liquid crystal film structure,

a plurality of phase-retardation regions integrally formed

though said first and/or second principal surfaces,

wherein each said phase-retardation region has an optical axis and birefringent phase-retardation characteristics for imparting a predetermined amount of phase retardation to a characteristic wavelength of said incident light passing through said phase-retardation region;

wherein said liquid crystal molecules over each said phase-retardation region are reoriented along a specified orientation direction to a predetermined depth within said solid-state liquid crystal film structure,

said optical axis extends along said specified orientation direction, and

said predetermined amount of phase retardation is determined by said predetermined surface depth to which the right-handed cholesterically ordered liquid crystal molecules within said phase-retardation region are reoriented along said specified orientation direction.

12. A cholesteric liquid crystal linear polarizer comprising:

a solid-state liquid crystal film structure having first and second principal surfaces, and left-handed cholesterically ordered liquid crystal molecules distributed over at least a selected portion of said solid-state liquid crystal film structure, for reflecting left-hand circularly polarized light within a predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure, while transmitting either right-hand circularly polarized light or incident light having a wavelength outside within said predetermined characteristic

reflection bandwidth;

a quarter-wave phase-retardation region integrally formed though said first or second principal surface, having an optical axis and birefringent phase-retardation characteristics for imparting $\pi/2$ radians phase retardation to a characteristic wavelength of said incident light passing through said phase-retardation region;

wherein said left-handed cholesterically ordered liquid crystal molecules over said phase-retardation region are reoriented along a specified orientation direction to a predetermined depth within said solid-state liquid crystal film structure,

said optical axis extends along said specified orientation direction, and

said $\pi/2$ radians phase retardation is determined by said predetermined surface depth to which the left-handed cholesterically ordered liquid crystal molecules within said phase-retardation region are reoriented along said specified orientation direction,

whereby left-handed circularly polarized light within said predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure and passing through said quarter-wave phase-retardation region is converted into linearly polarized light as it emanates therefrom.

13. A cholesteric liquid crystal linear polarizer comprising:

a solid-state liquid crystal film structure having first and second principal surfaces, and right-handed cholesterically ordered liquid crystal molecules distributed over at least a selected portion of said solid-state liquid crystal film structure, for reflecting right-hand circularly polarized light within a predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure, while transmitting either left-hand circularly polarized light or incident light having a wavelength outside within said predetermined characteristic reflection bandwidth;

a quarter-wave phase-retardation region integrally formed though said first or second principal surface, having an optical axis and birefringent phase-retardation characteristics for imparting $\pi/2$ radians phase retardation to a characteristic wavelength of said incident light passing through said phase-retardation region;

wherein said right-handed cholesterically ordered liquid crystal molecules over said phase-retardation region are reoriented along a specified orientation direction to a predetermined depth within said solid-state liquid crystal film structure,

said optical axis extends along said specified orientation direction, and

said $\pi/2$ radians phase retardation is determined by said predetermined surface depth to which the right-handed cholsesterically ordered liquid crystal molecules within said phase-retardation region are reoriented along said specified orientation direction,

whereby right-handed circularly polarized light within said predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure and passing through said quarter-wave phase-retardation region is converted into linearly polarized light as it emanates therefrom.

14. A cholesteric linear polarizer, comprising:

a solid-state liquid crystal film structure having first and second principal surfaces, and cholesterically ordered liquid crystal molecules distributed over a circularly polarizing region of said solid-state liquid crystal film structure, for reflecting circularly polarized light having a predetermined circular polarization state and a wavelength within a predetermined characteristic reflection bandwidth, incident said selected portion of said solid-state film structure, while transmitting either circularly polarized light having a polarization state different than said predetermined circular polarization state or a wavelength outside within said predetermined characteristic reflection bandwidth;

said predetermined circular polarization state being determined by the direction of cholesteric ordering of said liquid crystal molecules within said circularly polarizing region;

a quarter-wave phase-retardation region integrally formed though said first or second principal surfaces, having an optical axis and birefringent phase-retardation characteristics for imparting $\pi/2$ radians phase retardation to a characteristic

wavelength of said incident light passing through said phase-retardation region;

wherein said cholesterically ordered liquid crystal molecules over said quarter-wave phase-retardation region are reoriented along a specified orientation direction to a predetermined depth within said solid-state liquid crystal film structure,

said optical axis extends along said specified orientation direction, and

said $\pi/2$ radians phase retardation is determined by said predetermined surface depth to which the cholesterically ordered liquid crystal molecules within said phase-retardation region are reoriented along said specified orientation direction,

whereby circularly polarized light having a polarization state different than said predetermined circular polarization state or a wavelength outside said predetermined characteristic reflection bandwidth, incident said circularly polarizing region and passing through said quarter-wave phase-retardation region is converted into linearly polarized light as it emanates therefrom.

15. A liquid crystal micropolarization panel comprising:

a cholesteric liquid crystal film structure having a distribution of liquid crystal molecules, for imparting a predetermined circular polarization state to incident light passing therethrough;

a first plurality of birefringent phase-retardation regions realized in the surface of said cholesteric liquid crystal film structure by orienting the liquid crystal molecules at a first

surface depth and along first molecular orientation direction;

a second plurality of birefringent phase-retardation regions spatially alternating with said first plurality of birefringent phase-retardation regions, and realized in the surface of said cholesteric liquid crystal film structure by orienting the liquid crystal molecules at a second surface depth and along second molecular orientation direction;

wherein each one of said first plurality of birefringent phase-retardation regions and said cholesteric liquid crystal film structure constitute a left image pixel region having a first linear polarization state, and

each one of said second plurality of birefringent phase-retardation regions and said cholesteric liquid crystal film structure constitute a right image pixel region having a second linear polarization state, orthogonal to said first linear polarization state.

16. A linear micropolarization panel comprising:

a solid-state cholesteric liquid crystal film structure having first and/or second primary surfaces thereof, for imparting a predetermined circular polarization state to incident light passing therethrough;

a plurality of birefringent phase-retardation regions formed through said first and/or second primary surfaces, each said birefringent phase-retardation region having a distribution of liquid crystal molecules oriented along a specified molecular orientation direction, and an optical axis extending along the

direction of said molecular orientation direction; and

a plurality of linear polarizing regions spatially coincident with said plurality of birefringent phase-retardation regions, respectively, wherein each said linear polarizing region has a linear polarizing direction extending said optical axis of said spatially coincident birefringent phase-retardation region.

17. A method for making a liquid crystal phase retarder comprising the steps of:

(a) providing a liquid crystal film structure having cholesterically ordered liquid crystal molecules distributed between the first and second principal surfaces thereof; and

(b) orienting the liquid crystal molecules along the surface of said solid-state liquid crystal film structure in a particular direction and to a particular depth so as to form therein one or more phase retardation regions, each having an optical axis extending along the direction of orientation of said liquid crystal molecules, such that a particular amount of phase retardation is imparted to incident light passing therethrough.

18. A method for making a liquid crystal linear polarizer which comprises the steps of:

(a) providing a liquid crystal film structure having liquid crystal molecules distributed between the first and second principal surfaces thereof in accordance with a cholesteric ordering so that said distribution of liquid crystal molecules circularly polarizes light in a predetermined circular polarization direction; and

(b) orienting the liquid crystal molecules along the surface of said solid-state liquid crystal film structure in a particular direction and to a particular depth so as to integrally form therein one or more phase retardation regions, each having an optical axis extending along the direction of orientation of said liquid crystal molecules, such that a particular amount of phase retardation is imparted to incident light passing therethrough.

19. A method for producing birefringent phase retardation regions in a sheet of liquid crystal film, comprising the steps of:

(a) providing a sheet of liquid crystal film in a liquid or soft state; and

(b) exposing the liquid crystal molecules along a specified region of said film to an electric force field while said liquid crystal molecules are in their liquid state, whereby the electric force field intensity aligns said liquid crystal molecules along a desired direction of molecular reorientation, and at a molecular depth sufficient to achieve the desired phase retardation and an optical axis direction over said specified region.

20. The method of claim 19, wherein step (b) comprises exposing said liquid crystal molecules to polarized UV light.

21. The method of claim 19, which further comprises after step (b):

(c) curing said sheet of liquid crystal film.

22. A method for producing such phase retardation regions in a sheet of cholesterically ordered liquid crystal film, comprising the steps of:

(a) providing a sheet of cholesterically ordered liquid crystal film; and

(b) reorienting the cholesterically ordered molecules along the surface of said film by mechanically rubbing or burnishing the surface thereof along a desired direction of molecular reorientation, and at a surface pressure sufficient to achieve the depth of molecular reorientation required to achieved the desired phase retardation over the burnished region.

23. A method of forming the cholesteric liquid crystal polarizer comprising:

(a) forming a patterned or unpatterned phase retardation region into a first layer of CLC film material comprising a particular mixture;

(b) formed a second CLC film layer using the same particular mixture used to form said first layer of CLC film; and

(c) laminating said first and second layers of CLC film material together to form a single CLC film structure.

24. A liquid crystal film structure, comprising:

liquid crystal molecules distributed along a surface, wherein one or more birefringent phase-retardation regions are realized along said surface, each said birefringent phase-retardation having an optical axis specified by the direction of ordering of said liquid crystal molecules therein.

25. A liquid crystal linear polarizer, comprising:

a cholesteric liquid crystal (CLC) film structure having liquid crystal molecules therein,

wherein a birefringent phase-retardation region is formed along the surface of said CLC film structure by way of reorientation of liquid crystal molecules therein.

26. A liquid crystal film structure comprising:

first and second surfaces; and

one or more surface-based birefringent phase-retardation regions formed on said first and/or second surfaces thereof,

wherein the direction of the optical axis of each surface-based phase-retardation region is determined by the direction of molecular orientation effected therein.

27. A liquid crystal film structure, comprising:

a distribution of liquid crystal molecules;

one or more birefringent phase-retardation regions formed in said distribution of liquid crystal molecules,

wherein the amount of phase retardation imparted to light passing through each birefringent phase-retardation region is determined by the surface depth of orientation of said liquid crystal molecules within said birefringent phase retardation region, and the optical axis of the phase retardation region is determined by the direction of molecular orientation effected

therein.

28. A cholesteric linear polarizer with a single characteristic polarization direction comprising:

a single cholesteric liquid crystal (CLC) film structure; and

a birefringent phase-retardation region formed along at least one surface of said single CLC film structure.

29. A cholesteric linear polarizer comprising:

a single cholesteric liquid crystal (CLC) film structure having first and second primary surfaces; and

one or more birefringent phase-retardation regions formed on said first and/or second primary surfaces of said single CLC film structure, so that a plurality of spatially-defined characteristic polarization directions are realized therein.

30. A micropolarization panel having left and right pixel regions realized on a single sheet of CLC film comprising liquid crystal molecules,

wherein the left pixel regions have a first linear polarization state (i.e. linear polarization direction) coincident with a first birefringent phase retardation region realized in said single sheet of CLC film by orienting the liquid crystal molecules at a first surface depth and along first reorientation direction to form a first plurality of linear polarizing elements, and

wherein the right pixel regions thereof have a second linear polarization state (i.e. linear polarization direction) coincident with a second birefringent phase retardation region

realized in said single sheet of CLC film by orienting the liquid crystal molecules at a second surface depth along second reorientation direction to form a second plurality of linear polarizing elements orthogonal to the first plurality of linear polarizing elements.

31. Apparatus for producing phase retardation regions in a sheet of CLC film by reorienting cholesterically ordered molecules along the surface of said sheet of CLC film, said apparatus comprising:

means for mechanically rubbing or burnishing the surface of said sheet of CLC film along the desired direction of molecular reorientation, and at a surface pressure sufficient to achieve the depth of molecular reorientation required to achieved a desired birefringent phase-retardation surface over said burnished region.

32. A tool for performing molecular reorientation of the cholesterically ordered molecules along selected regions of the surface of CLC film material.

33. A method for producing birefringent phase retardation regions in a sheet of soft CLC film, comprising the steps of:

(a) providing a sheet of soft (e.g. unpolymerized or heated) CLC film having liquid crystal molecules; and

(b) exposing said soft sheet of CLC film to UV light so that the liquid crystal molecules along the surface thereof align along a desired direction of molecular orientation, and at a molecular

depth sufficient to achieve a nematic ordering and the formation of a phase retardation region having an optical axis in the direction molecular orientation.

34. A system for reorientating liquid crystal molecules along selected regions of the surface of CLC film, said system comprising

means for producing UV light; and

means for exposing the surface of a sheet of soft CLC film to said produced UV light.

35. A CLC-based linear polarizer for use in constructing the pixel elements of LCD panels having high-brightness characteristics.

36. A CLC film structure having first and second principal surfaces, comprising:

one or more birefringent phase-retardation regions realized along said first and/or second principal surfaces thereof,

wherein each phase retardation region has an optical axis aligned along the direction of molecular orientation.

37. A liquid crystal polarizer comprising:

a single film structure having top and bottom surfaces, and cholesterically ordered molecules distributed between said top and bottom surfaces;

a first plurality of birefringent phase retardation regions formed at locations on said top surface thereof, each said birefringent phase retardation region imparting an amount of phase retardation to incident light (of wavelength λ) proportional

to depth of reorientation of the cholesterically ordered molecules in the film structure and having an optical axis extending along the direction of reorientation within that region; and

a second plurality of birefringent phase retardation regions formed at arbitrary locations on the bottom surface thereof, each said birefringent phase retardation region imparting an amount of phase retardation to incident light (of wavelength λ) proportional to depth of reorientation of the cholesterically ordered molecules of the film structure and having an optical axis extending along the direction of reorientation within that region.

38. A liquid crystal polarizer comprising:

a single film structure having top and bottom surfaces, and

cholesterically ordered molecules distributed between said top and bottom surfaces;

a first plurality of birefringent phase retardation regions formed at a first set of prespecified locations on the top surface thereof, each imparting an amount of phase retardation to incident light (of wavelength λ) proportional to depth of reorientation of the cholesterically ordered molecules of the film structure and having an optical axis extending along the direction of reorientation within that region; and

a second plurality of birefringent phase retardation regions formed at a second set of prespecified locations on the bottom surface thereof, spatially coincident (i.e. registered) with

the first plurality of phase retardation regions, each imparting an amount of phase retardation to incident light (of wavelength λ) proportional to the depth of reorientation of the cholesterically ordered molecules of the film structure and having an optical axis extending along the direction of molecular reorientation within that region.

39. A liquid crystal polarizer comprising:

a single film structure having said top and bottom surfaces and cholesterically ordered molecules between said top and bottom surfaces;

a birefringent phase retardation structure formed on said top surface achieved by orienting said cholesterically ordered molecules at a surface depth along a specified molecular orientation direction.

40. The liquid crystal linear polarizer of claim 39, wherein the pitch characteristics of said cholesterically ordered molecules approaches infinity where said birefringent phase retardation structure is formed in said a single film structure.

41. A liquid crystal polarizer comprising:

a single film structure having top and bottom surfaces and cholesterically ordered molecules with a non-linear pitch between said top and bottom surfaces; and

a phase retardation surface formed on said top surface by orienting the cholesterically ordered molecules at a surface depth along a specified molecular orientation direction.

42. The liquid crystal polarizer of claim 41, wherein the pitch characteristics of said cholesterically ordered molecules exhibit a large increase along said single film structure where the cholesterically ordered molecules have been reoriented to form the birefringent phase-retardation surface structure therein.

43. A liquid crystal polarizer comprising:

a single film structure having first and second surfaces and cholesterically ordered molecules therebetween, and

a birefringent phase retardation structure formed on said top surface thereof wherein said cholesterically ordered molecules are oriented at a surface depth along a molecular orientation direction.

44. The liquid crystal polarizer of claim 43, wherein the amount of phase shift imparted by said birefringent phase retardation structure at a central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a left-handed cholesteric (LHC) ordering, and incident light is produced from an unpolarized light source located on either side of said liquid crystal polarizer.

45. The liquid crystal polarizer of claim 43, wherein the amount of phase shift imparted by said birefringent phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said

cholesterically ordered molecules throughout the bulk of said single film structure have a right-handed cholesteric (RHC) ordering, and incident light is produced from an unpolarized light source located on either side of said liquid crystal polarizer.

46. The liquid crystal polarize of claim 43, wherein the amount of phase shift imparted by said birefringent phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a LHC ordering, and incident light is produced from a left-handed circularly polarized (LHCP) light source located on either side of said liquid crystal polarizer.

47. The liquid crystal polarizer of claim 43, wherein the amount of phase shift imparted by said birefringent phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a RHC ordering, and incident light is produced from a right-handed circularly polarized (RHCP) light source located on either side of said liquid crystal polarizer.

48. The liquid crystal polarizer of claim 43, wherein the amount of phase shift imparted by said birefringent phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a LHC ordering, and incident light is produced from a RHCP light source located on either side of said liquid crystal polarizer.

49. The liquid crystal polarizer of claim 43, wherein the amount of phase shift imparted by said birefringent phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure polarizer have a RHC ordering, and incident light is produced from RHCP light source located on either side of said liquid crystal polarizer.

50. A liquid crystal linear polarizer comprising:

a single film structure having top and bottom surfaces and cholesterically ordered molecules between said top and bottom surfaces;

a first phase retardation structure formed on said top surface thereof by orienting said cholesterically ordered molecules at a first depth along a first molecular orientation direction; and

a second phase retardation structure formed on said bottom surface by orienting the cholesterically ordered molecules at a second depth along a second molecular orientation direction.

51. A narrow-band liquid crystal linear polarizer comprising:

single film structure having top and bottom surfaces and cholesterically ordered molecules between said top and bottom surfaces having linear pitch characteristics;

a first phase retardation structure formed on said top surface by orienting the cholesterically ordered molecules at a

first depth along a first molecular orientation direction; and

a second phase retardation structure formed on said bottom surface by orienting the cholesterically ordered molecules at a second depth along a second molecular orientation direction.

52. The narrow-band liquid crystal polarizer of claim 51, wherein the pitch characteristics of said cholesterically ordered molecules approaches infinity at said top and bottom surfaces where said phase retardation structures are realized therein by way of molecular realignment.

53. A broad-band liquid crystal linear polarizer comprising:

a single film structure having top and bottom surfaces and cholesterically ordered molecules between said top and bottom surfaces having a non-linear pitch characteristics;

a first phase retardation structure formed on said top surface by orienting the cholesterically ordered molecules at a first depth along a first molecular orientation direction; and

a second phase retardation structure formed on said bottom surface by orienting the cholesterically ordered molecules at a second depth along a second molecular orientation direction.

54. The broad-band liquid crystal linear polarizer of claim 53, wherein the pitch characteristics of said cholesterically ordered molecules increase along said top and bottom surfaces where said cholesterically ordered molecules have been molecularly reoriented to form said first and second birefringent phase-retardation structures.

55. The broad-band liquid crystal linear polarizer of claim 53, wherein said pitch characteristics of said cholesterically ordered molecules increase exponentially between said top and bottom surfaces.

56. The broad-band liquid crystal polarizer of claim 53, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λC is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a LHC ordering, and incident light is produced from an unpolarized light source located on either side of said broad-band liquid crystal polarizer.

57. The broad-band liquid crystal polarizer of claim of 53, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a RHC ordering, and incident light is produced from an unpolarized light source located on either side of said broad-band liquid crystal polarizer.

58. The broad-band liquid crystal polarizer of claim 53, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a LHC ordering, and incident light is produced from a LHCP light source located on either side of said broad-band liquid crystal polarizer.

59. The broad-band liquid crystal polarizer of claim 53, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk of said single film structure have a RHC ordering, and incident light is produced from a RHCP light source located on either side of said broad-band liquid crystal polarizer.

60. A liquid crystal polarizer comprising:

a film structure having cholesterically ordered molecules throughout the bulk volume thereof;

first and second phase retardation structures formed in said film structure,

wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians,

the amount of phase shift imparted by second phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a LHC ordering, and incident light is produced from a RHCP light source located on either side of said liquid crystal polarizer.

61. The liquid crystal polarizer of claim 60, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is $\pi/2$ radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a RHC ordering, and incident light is produced from RHCP light source located on either side of the liquid crystal polarizer.

62. The liquid crystal polarizer of claim 60, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is π radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a LHC ordering, and incident light is produced from an unpolarized light source located on either side of said liquid crystal polarizer.

63. The liquid crystal polarizer of claim 60, wherein the amount of

phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is π radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a RHC ordering, and incident light is produced from an unpolarized light source located on either side of said liquid crystal polarizer.

64. The liquid crystal polarizer of claim 60, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by second phase retardation structure at central wavelength λ_C is π radians said cholesterically ordered molecules throughout the bulk volume of said film structure have a LHC ordering, and incident light is produced from a LHCP light source located on either side of the liquid crystal polarizer.

65. The liquid crystal polarizer of claim 60, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is π radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a RHC ordering, and the incident light is produced from a RHCP light source located on either side of said liquid crystal polarizer.

66. The liquid crystal polarizer of claim 60, wherein the amount of

phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is π radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a LHC ordering, and the incident light is produced from a RHCP light source located on either side of said liquid crystal polarizer.

67. The liquid crystal polarizer of claim 60, wherein the amount of phase shift imparted by said first phase retardation structure at central wavelength λ_C is $\pi/2$ radians, the amount of phase shift imparted by said second phase retardation structure at central wavelength λ_C is π radians, said cholesterically ordered molecules throughout the bulk volume of said film structure have a RHC ordering, and the incident light is produced from RHCP light source located on either side of the liquid crystal polarizer.

68. A liquid crystal phase-retarder comprising:

a liquid crystal film structure having liquid crystal molecules along the bulk volume thereof; and

one or more phase retardation regions formed therein, each said phase retardation region having an optical axis specified by the direction of liquid crystal molecules along the surface of said liquid crystal film structure and phase retardation characteristics specified by the depth of orientation of liquid crystal molecules along the surface of said liquid crystal film structure.

69. A liquid crystal linear polarizer comprising:

a liquid crystal film structure having a chiral phase region within which liquid crystal molecules are cholesterically ordered; and

one or more nematic phase regions formed along the surface of said liquid crystal film structure,

wherein the liquid crystal molecules within each said nematic phase region are oriented along a direction and to a surface depth sufficient to realize a phase retardation region therein having an optical axis and phase retardation characteristics associated therewith;

wherein the optical axis of each said phase retardation region is disposed along the direction of orientation of said liquid crystal molecules within said corresponding nematic phase region, and

wherein the phase retardation characteristics of each said phase retardation region is specified by the surface depth of said liquid crystal molecules oriented along the surface of said liquid crystal film structure.

70. Apparatus for making a liquid crystal phase retarder comprising:

providing means for providing a liquid crystal film structure having cholesterically ordered liquid crystal molecules distributed between the first and second principal surfaces thereof; and

orienting means for orienting the liquid crystal

molecules along the surface of said solid-state liquid crystal film structure in a particular direction and to a particular depth so as to form therein one or more phase retardation regions, each having an optical axis extending along the direction of orientation of said liquid crystal molecules, such that a particular amount of phase retardation is imparted to incident light passing therethrough.

71. Apparatus for making a liquid crystal linear polarizer which comprises:

providing means for providing a liquid crystal film structure having liquid crystal molecules distributed between the first and second principal surfaces thereof in accordance with a cholesteric ordering so that said distribution of liquid crystal molecules circularly polarizes light in a predetermined circular polarization direction; and

orienting means for orienting the liquid crystal molecules along the surface of said solid-state liquid crystal film structure in a particular direction and to a particular depth so as to integrally form therein one or more phase retardation regions, each having an optical axis extending along the direction of orientation of said liquid crystal molecules, such that a particular amount of phase retardation is imparted to incident light passing therethrough.

72. Apparatus for producing birefringent phase retardation regions in a sheet of liquid crystal film, comprising:

providing means for providing a sheet of liquid crystal film in a liquid or soft state; and

exposing means for exposing the liquid crystal molecules along a specified region of said film to an electric force field while said liquid crystal molecules are in their liquid state, whereby the electric force field intensity aligns said liquid crystal molecules along a desired direction of molecular reorientation, and at a molecular depth sufficient to achieve the desired phase retardation and an optical axis direction over said specified region.

73. The apparatus of claim 72, wherein said exposing means comprises:

means for producing polarized UV light; and

means for exposing said liquid crystal molecules to said produced polarized UV light.

74. The apparatus of claim 72, which further comprises:

means for curing said sheet of liquid crystal film.

75. Apparatus for producing such phase retardation regions in a sheet of cholesterically ordered liquid crystal film, comprising:

providing means for providing a sheet of cholesterically ordered liquid crystal film; and

reorienting means for reorienting the cholesterically ordered molecules along the surface of said film by mechanically rubbing or burnishing the surface thereof along a desired direction of molecular reorientation, and at a surface pressure sufficient to achieve the depth of molecular reorientation required

to achieved the desired phase retardation over the burnished region.

76. Apparatus for forming the cholesteric liquid crystal polarizer comprising:

first forming means for forming a patterned or unpatterned phase retardation region into a first layer of CLC film material comprising a particular mixture;

second forming means for forming a second CLC film layer using the same particular mixture used to form said first layer of CLC film; and

laminating said first and second layers of CLC film material together to form a single CLC film structure.

77. A method of fabricating a linear CLC polarizer, comprising the steps of:

(a) forming a phase retardation region in a first layer of polymerizable CLC film material having nematic phase characteristics;

(b) forming a second layer of CLC film material having chiral phase characteristics; and

(c) laminating said first and second layers of CLC film material together in order to form a single composite CLC film structure whereby said single composite CLC film structure consists essentially of the same type of CLC material and has a circularly polarizing layer as well as one or more phase retardation regions present therein.

78. The method of claim 77, wherein step (c) comprises matching of the indices of refraction of said first and second CLC layers so that said single composite CLC film structure exhibit a high light transmission efficiency.

79. The method of claim 77, wherein said phase retardation region in said first layer imparts a $\pi/2$ phase shift to incident light so that said single composite CLC film structure functions a linear polarizer.

80. A composite CLC film structure comprising:

a first layer of CLC film material having formed therein a phase retardation region with nematic phase characteristics; and

a second layer of CLC film material having chiral phase characteristics, and being laminated to said second layer of CLC film material to form a single composite CLC film structure ,

wherein said single composite CLC film structure consists essentially of the same type of CLC material and has a circularly polarizing layer as well as one or more phase retardation regions present therein.

81. The composite CLC film structure of claim 81, wherein the indices of refraction of said first and second CLC layers are matched so that said single composite CLC film structure exhibits high light transmission efficiency.

82. The composite CLC film structure of claim 81, wherein said

phase retardation region in said first layer imparts a $\pi/2$ phase shift to incident light so that said single composite CLC film structure functions a linear polarizer.